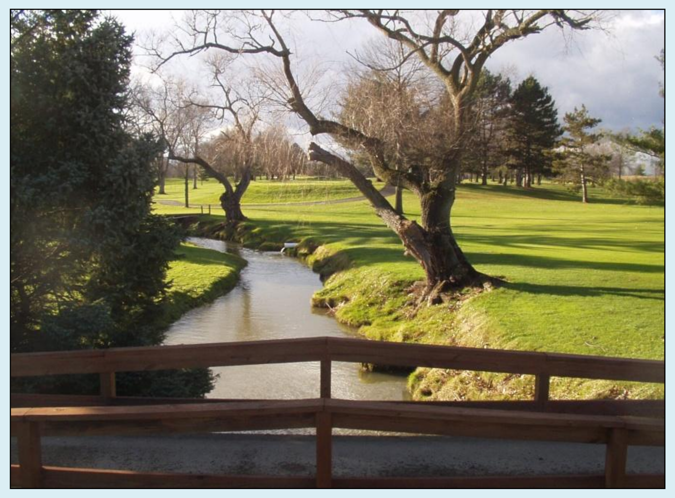

Continuous dissolved oxygen measurements reveal metabolic patterns in a mixed land use stream

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Introduction

Streams receive, convey, and ecologically process inputs, such as nutrients and organic matter, within watersheds. Metabolic activity in stretches of a stream can serve as an indicator of these functions.

When autotrophic organisms photosynthesize (primary production), they produce oxygen. When organisms respire, they consume oxygen. Thus, dissolved oxygen (DO) concentration in a stream will reflect total aquatic system metabolism. Continuously monitoring DO can reveal fine-scale patterns in metabolism.

Because light drives photosynthesis, daily light cycles create diel (24-hour) metabolic patterns. Rain events increase runoff input to streams and can amplify land use effects on aquatic system metabolism. In an attempt to capture these patterns, we deployed continuously-monitoring DO probes in Plum Creek, a small stream flowing through mixed land use in northeast Ohio. This fine-scale data could allow researchers to analyze the health and function of Plum Creek, a stream that plays an important role in nutrient processing in the Lake Erie Basin.

Goals

- Conduct trial for method of *in situ*, continuous DO monitoring in Plum Creek.
- Relate DO patterns to:
  - Diurnal light cycles
  - Rain events
  - Different land use types
  - Different time scales

Methods

We deployed probes at three sequential sampling locations along Plum Creek. In addition to water from upstream, each location receives runoff from different land use types: agricultural (**Hamilton St**), mixed golf course, forest, and urban (**Morgan St**), and urban (**Hwy 511**).

Probes and data loggers continuously collected data at 30 minute intervals for ten full days (25 Oct 2010 to 3 Nov 2010).
Probes measured:

- DO (O_2 mg/L)
- Temperature (°C)
- Light (lum/ft^2)
- Stream depth (ft) at Morgan Street

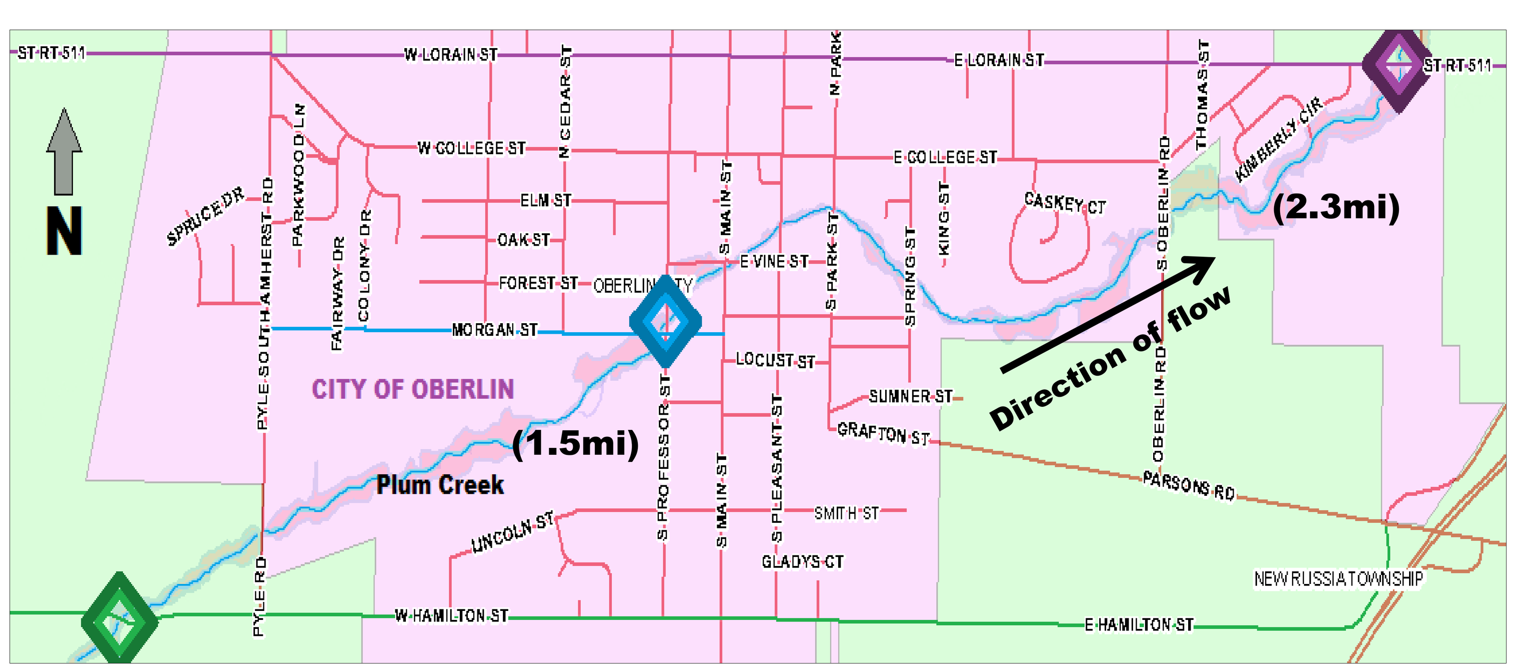

Fig. 1: Map of study sites. Distances between sites are in parentheses. Diamonds indicate sampling sites: **Hamilton St**, **Morgan St**, and **Hwy 511**.

Results I: Site Comparisons

DO concentrations show diel patterns across sites, increasing during daylight and decreasing at night. Increase in DO is associated with a steady decrease in temperature over the week. DO concentration decreased from upstream to downstream sites.

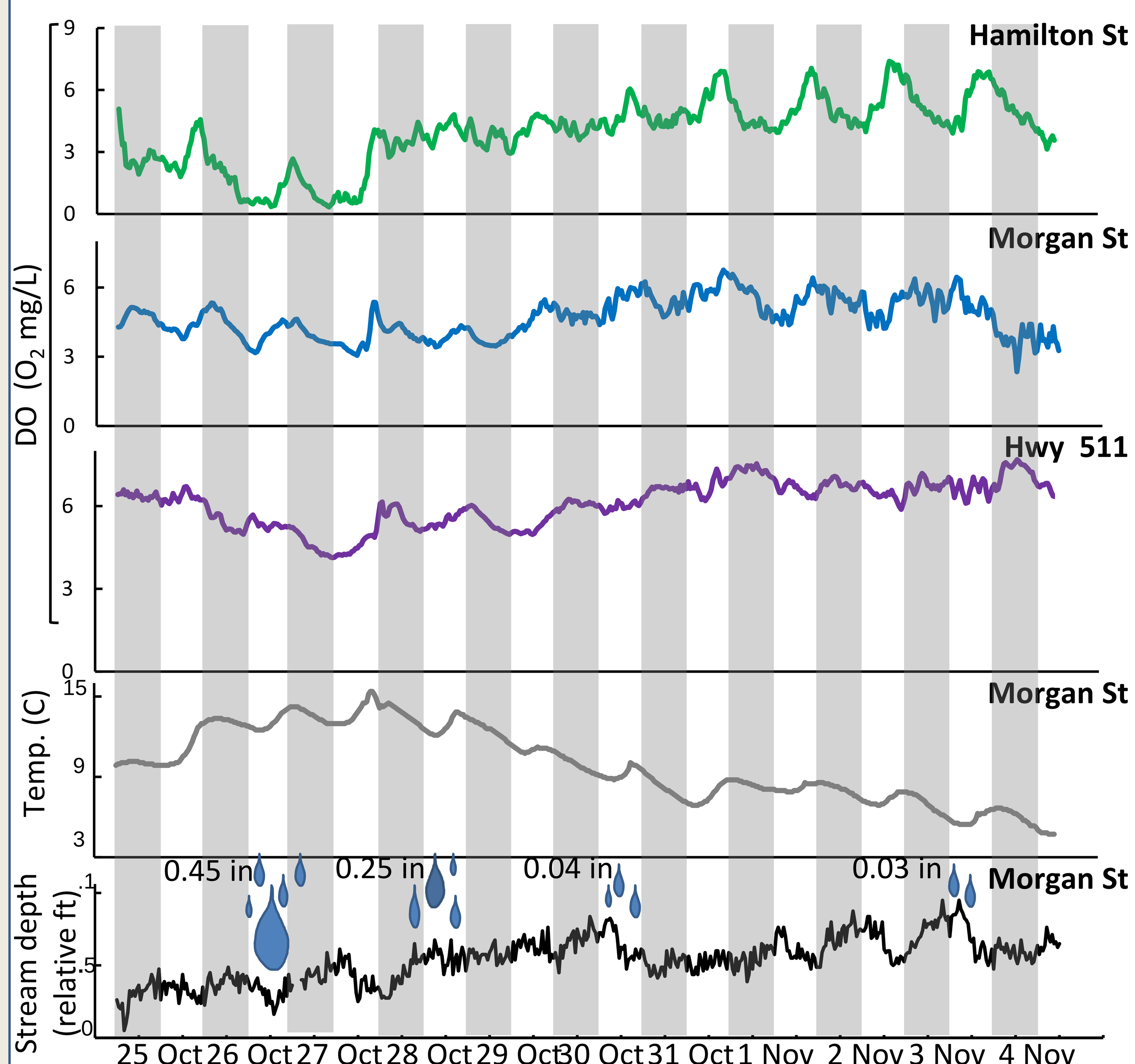

Fig. 2: Continuous DO concentration (O_2 mg/L) at all sites over ten day period. Precipitation is indicated by raindrops and amount of rainfall. Gray columns represent 6pm-6am (approximate dark hours) and white columns represent 6am-6pm (approximate light hours).

Results II: Effects of Temporal Scale

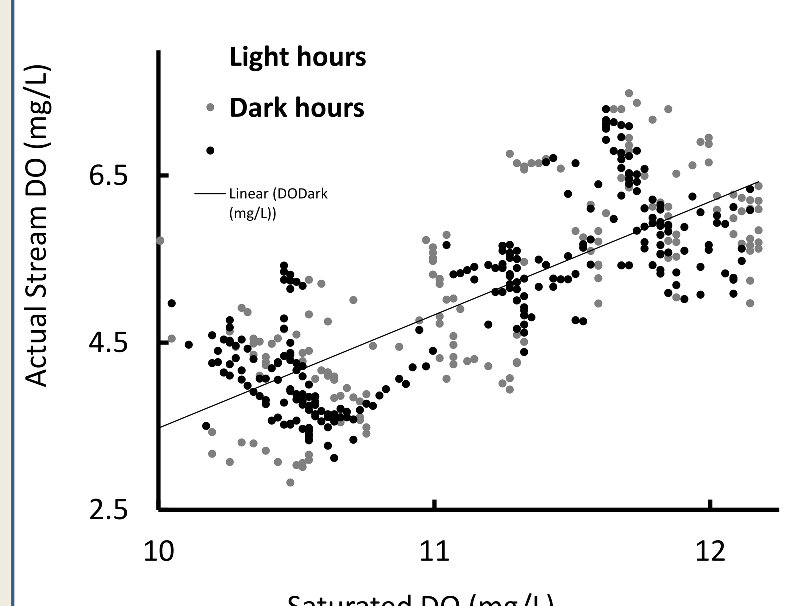

Fig. 3: Correlation between saturated DO and actual DO over 8 days

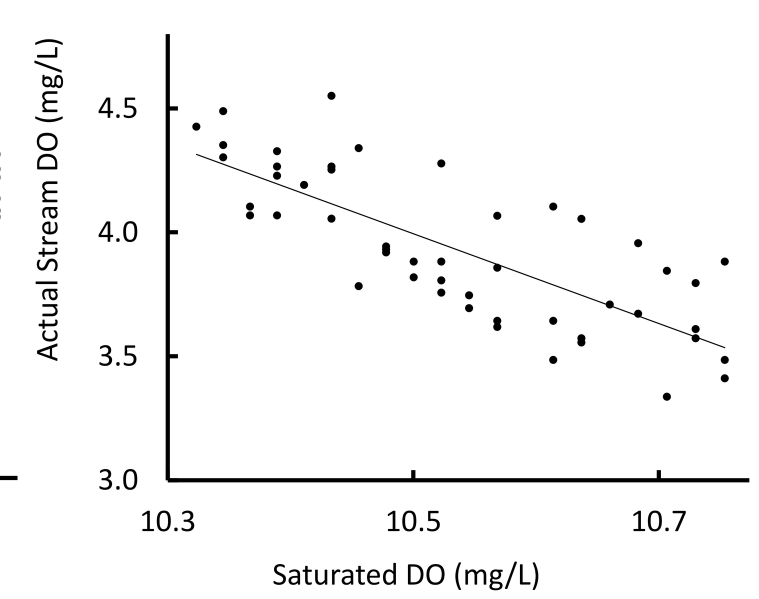

Fig. 4: Correlation between saturated DO and actual DO over a 24-hour period

Saturated DO is the equilibrium concentration of oxygen dissolved in water at a given temperature.

• Over the week, DO concentration had a positive correlation with saturated DO (Fig. 3), indicating a response to physical changes associated with diffusion (e.g. temperature) that did not differ over light and dark hours.

• During a 24-hour period, there was a negative correlation (Fig. 4), suggesting that different processes (e.g. biological activity) control DO concentrations at smaller time scales.

Results III: Biological Activity Patterns

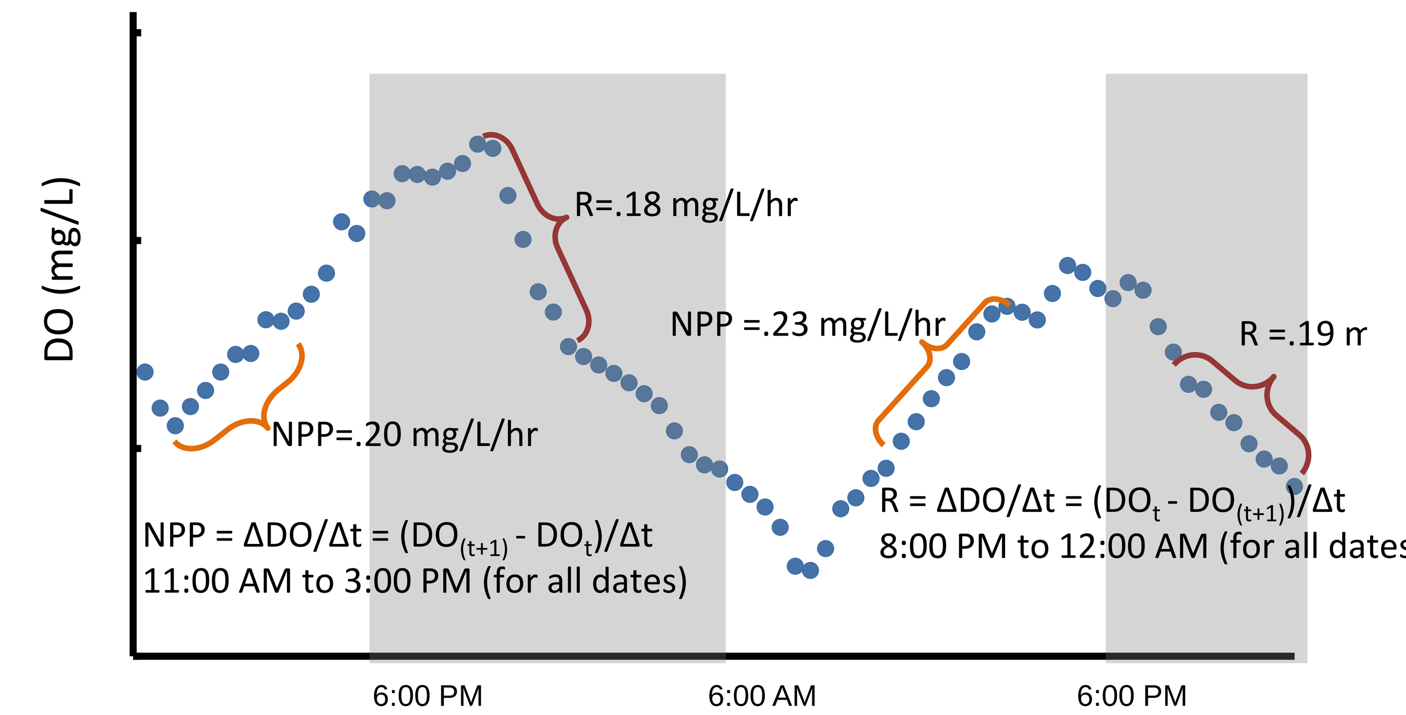

Fig. 5: Illustration of use of fixed time interval to calculate Net Primary Productivity (NPP) and respiration (R). Rate of increase in DO during day light interpreted as NPP. Rate of decrease in DO during dark hours interpreted as respiration.

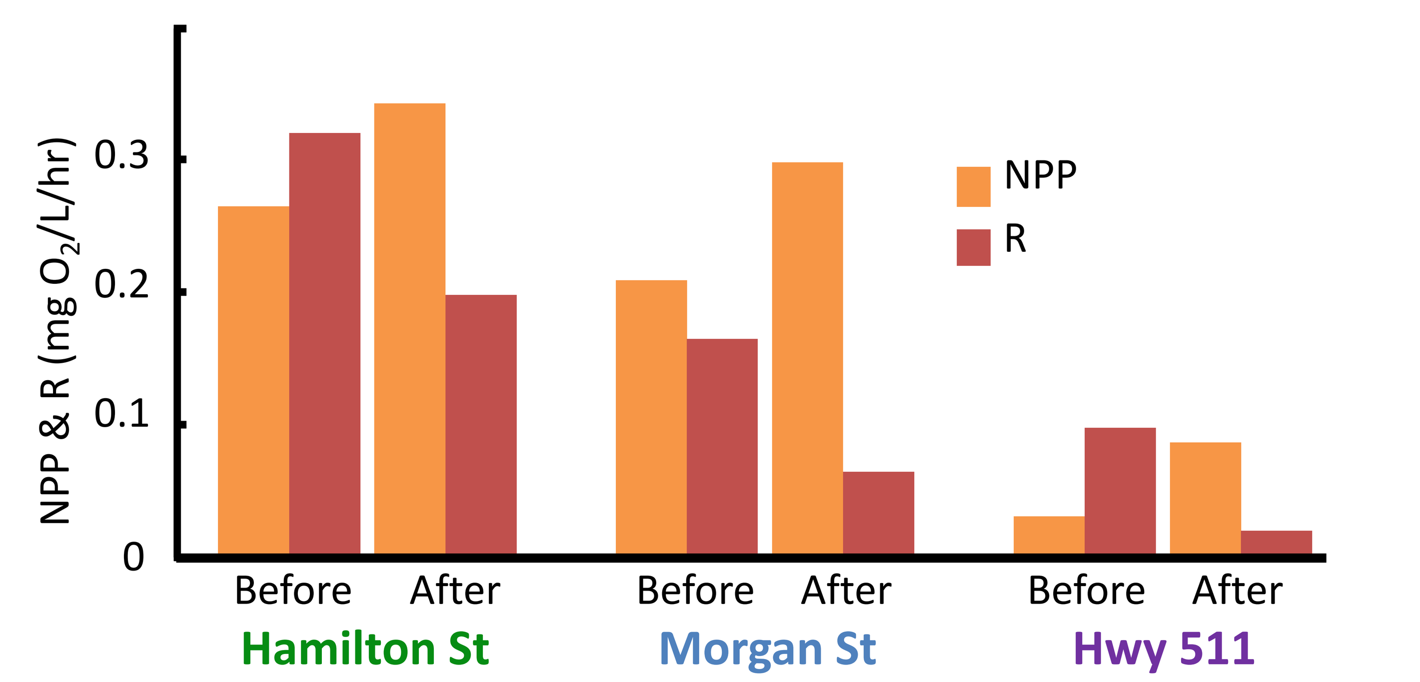

Fig. 6: NPP and R at each site before (25 Oct) and after (average of 26-28 Oct) a rain event on 26 Oct. After the rain event, NPP increased and R decreased.

Conclusions and Next Steps

Our analysis of continuous DO collected over ten days in autumn produced preliminary conclusions:

• Continuous DO reveals fine-scale patterns in stream metabolism.
• Daily light cycles produce diel patterns in dissolved oxygen associated with productivity and respiration (Fig. 2).
• Net primary productivity increases after rain events, potentially as a result of increased nutrient inputs from agricultural and urban runoff. Respiration decreases, potentially as a result of dilution (Fig. 6).
• Differences in magnitude and patterns of DO across sampling locations suggest variations in metabolic activity in stream stretches, perhaps associated with different land use types (Fig. 2).
• Physical processes strongly influence DO at the multi-day scale, while biological processes strongly influence DO at the diel scale (Fig. 3 and 4).

Future studies should measure water flow rates in order to track changes in metabolism over the course of the stream. Continuous data taken over a longer term, and during different seasons, would allow further study of effects of scale and seasonality on system metabolism patterns.

Acknowledgments

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